## Space Weather Technical Forecast

Issued on Thursday 13 February 2025 at 00:33 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Chance G1 Minor Storms, mainly day 1-2 (13-14 Feb) due to the transition into the faster solar winds from CH14/-**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Low with peak flare C3.9 at 12/1247 UTC from a plage region in the northeast. The are seven sunspot regions on the disc, however these are all magnetically simple and relatively small. The main growth was in AR3992 just west of the south-centre disc, developing a mature leader and trailer spot, however this has remained inactive.

No Earth-directed CME's were observed from available imagery.

**Solar Wind / Geomagnetic Activity:** Connection to the fast wind from CH13/- likely eased, but with a potential connection to the fast wind from the leading portion of CH14/-. Solar wind speeds have been elevated at between 500-570km/s, before easing to be slightly elevated at 450-500km/s. Density was below average. Interplanetary Magnetic Field strength, Bt, was weak at 4-7nT with north-south component, Bz, also weak and variable in direction, but slightly favouring negative (southwards-directed) conditions. This ranged between -6nT to +6nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp2-3) with one interval of Active (Kp4) at 12/0300-0600 UTC.

**Energetic Particles / Solar Radiation:** High energy proton flux at GOES18 persisted at background. High energy electron flux (greater than 2MeV) at GOES16 was Moderate at first but rose to be predominately High from 12/1145 UTC, reaching a peak of 2050pfu at 11/1745 UTC. The associated 24-hour fluence persisted below the Active threshold, recording 7.64e7 integrated pfu at 13/0000UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Moderate to Low activity expected with a chance of further M-class flares.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs. Current fast winds, either from CH13/- easing or the initial portion of CH14/- are expected to become further enhanced later day 1 and into day 2 (13-14 Feb), reaching Elevated to Strong speeds. These winds are likely to continue day 3-4 (15-16 Feb). Mainly Unsettled to Active geomagnetic activity with slight chance of G1 Minor Storm intervals, but likely becoming Active with a chance of G1 Minor Storms ahead of the onset of the Elevated to Strong winds later day 1 or day 2 (13-14 Feb).

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**Energetic Particles / Solar Radiation:** High energy proton flux at GOES18 is forecast to persist at background. High energy electron flux observed at GOES16 is likely to persist at High at first, but with a chance of some suppression in observed values with the onset of the Elevated to Strong solar winds day 1-2 (13-14 Feb). Confidence is then lower for the recovery later in the period, however there is a likelihood of further extended periods of High flux. The associated 24 hour fluence is likely to reach the Active level on day 1 (13 Feb), with a chance of continuing into day 2 (14 Feb). Confidence then becomes low, but with a chance of ongoing Active fluence day 3-4 (15-16 Feb).

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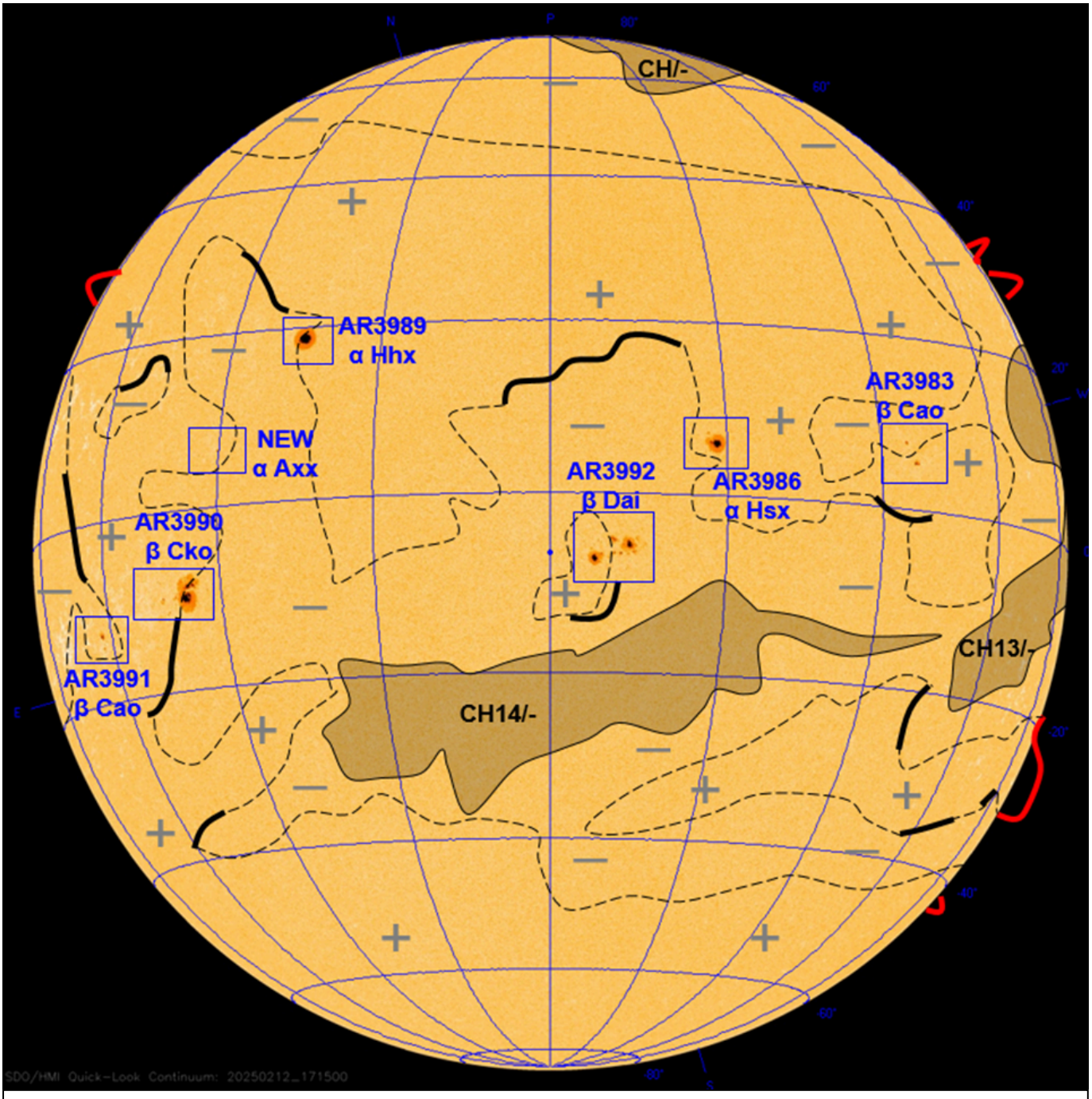
**Figure 1: MOSWOC Solar Synoptic Map 12/1715 UTC**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms

There are no Earth-directed CMEs.

Solar winds are currently slightly elevated, perhaps due to the tail end of CH13/-, but more likely from the initial connection to the fast wind from the narrow leading edge portion of CH14/-. Later day 1 (13 Feb) this is forecast to become further enhanced with the likely arrival of Elevated to Strong winds from the darker bulk portion of this feature, which extends over 50 degrees in longitude across the southern hemisphere. The onset of these winds, could be preceded by a CIR region which could bring elevated geomagnetic activity, before transitioning into more typical high speed stream (HSS) conditions for the rest of the period. This feature is likely to be well connected to Earth, given its negative polarity and Earth's current location south of the ecliptic.

Unsettled to Active geomagnetic conditions at first with a slight chance of G1 Minor Storm intervals. These are likely to become mainly Active with a chance of G1 Minor Storm intervals by the end of day 1, and continuing into day 2 (13-14 Feb). As Earth moves through the HSS on days 3-4 (15-16 Feb) Unsettled to Active geomagnetic activity is expected to return with a slight chance of G1 Minor Storm intervals.

| Geomagnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 50 | 40 | 10 | 5 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

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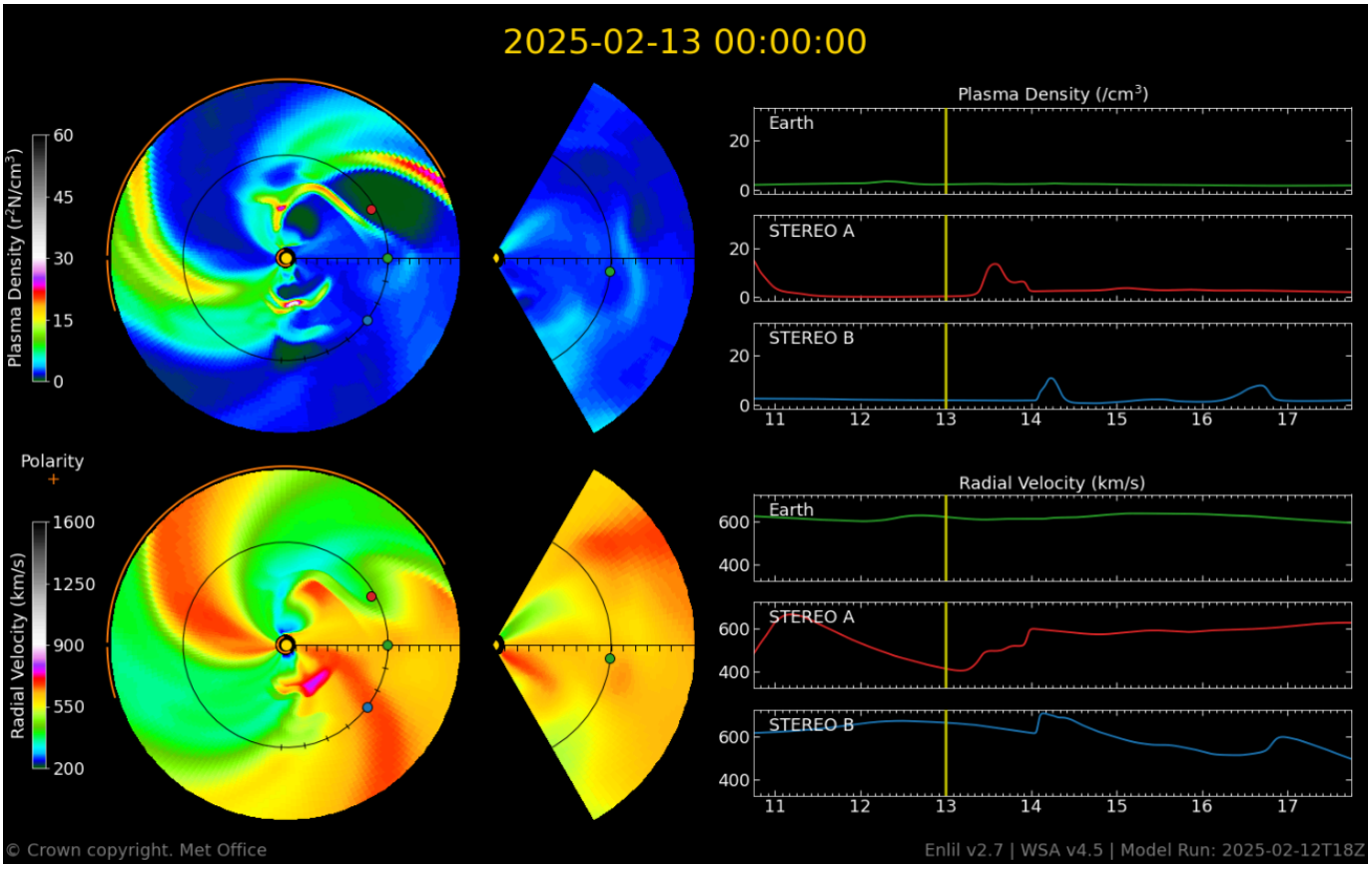
**Figure 2: MOSWOC Enlil**



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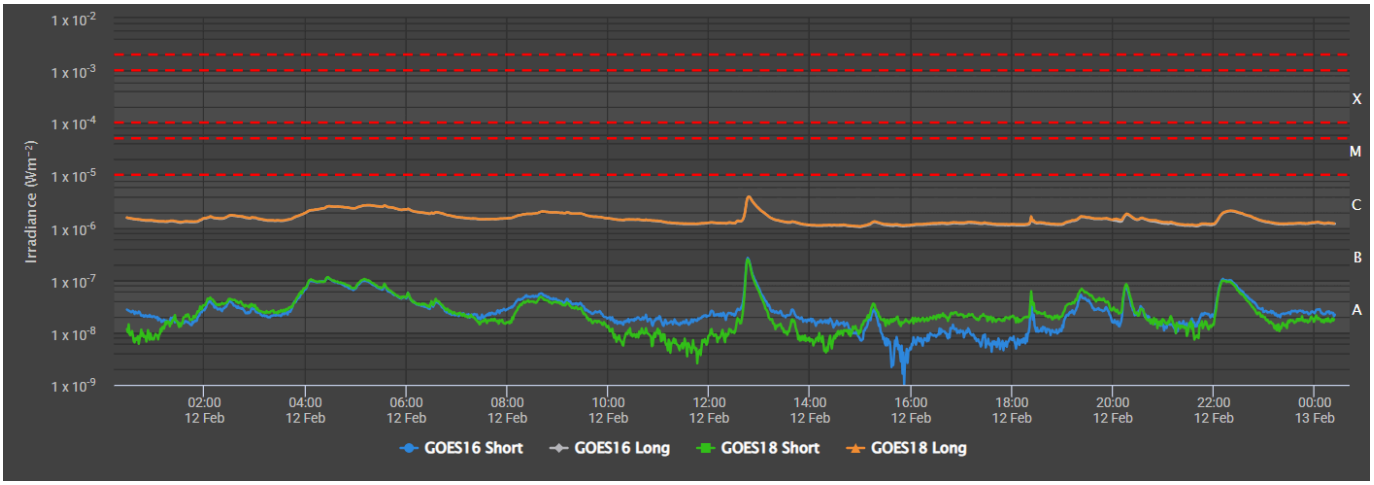
## Radio Blackouts - X-Ray Flares

Low to Moderate solar activity is forecast. There is a chance of further isolated M-class flares, mainly due to the potential of AR3992 to develop into a complex region.

There are seven sunspots on the Earth-facing disc, all of which are relatively small and simple. AR3990 is the most complex. This is primarily comprised of a large leader spot with some splitting of the penumbra, and smaller trailer spots. AR3992 has developed quite rapidly and currently appears relatively simple but has potential for further growth.

| X-Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 (M Class) | No | 40 | 40 | 50 | 50 |
| Very Active | R3-R5 (X Class) | No | 1 | 1 | 1 | 1 |

**Figure 3: GOES 16-18 X-ray Irradiance**

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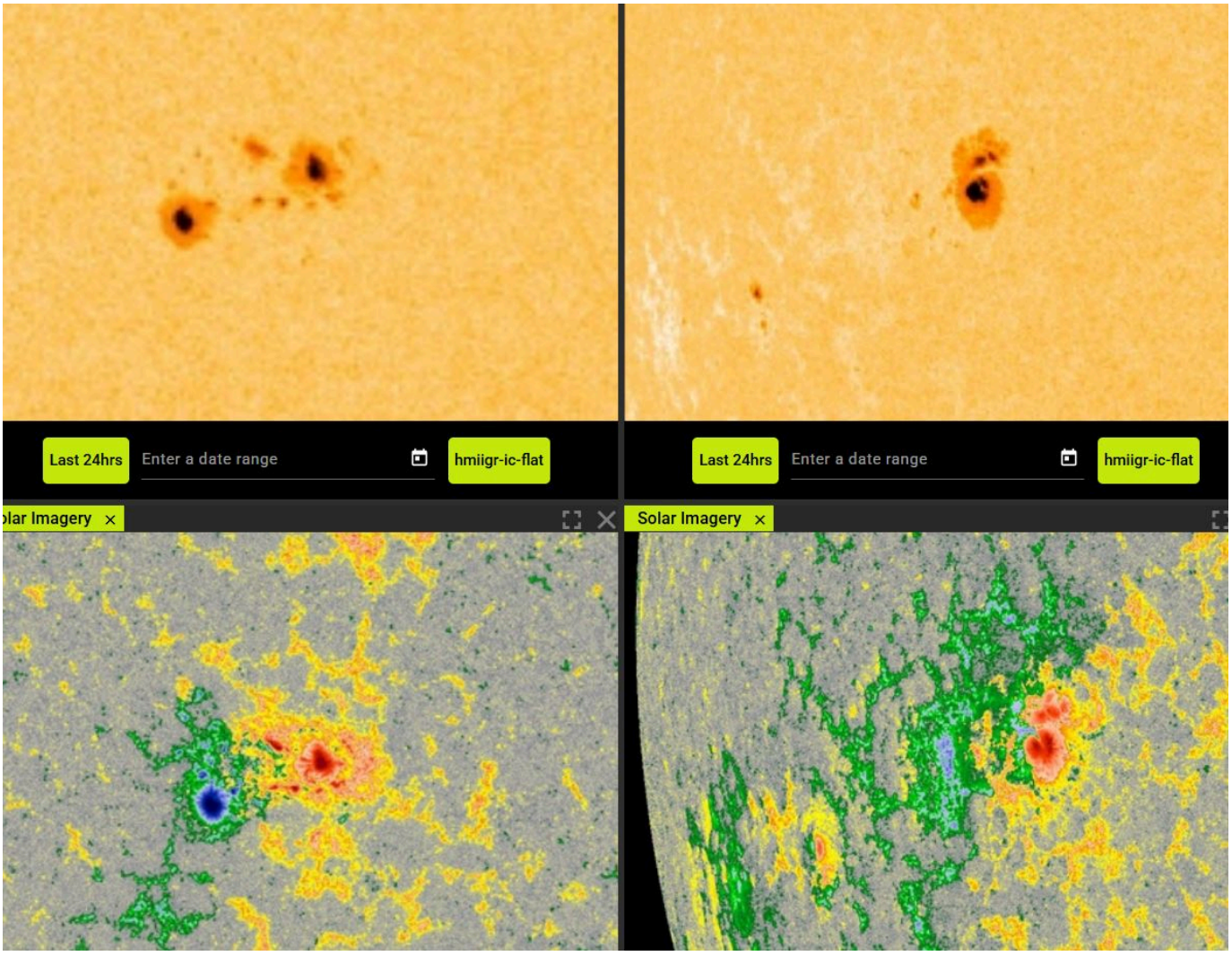
## Solar Radiation Storms (High Energy Protons)

GOES-16 proton flux is forecast to persist at background with only a very slight chance of enhancement from any notable flares, given the simplicity of the sunspot regions currently on the visible disc.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}sr^{-1}s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: SDO Intensitygram (top) and Magnetogram (bottom) of new AR3992 (left) and AR3990/AR3991 (right)**

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## High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been Moderate to High and showing a rising trend day-by-day due to the connection to the fast wind of CH13/- and any potential initial connection to CH14/-. This enhancement is likely to continue through day 1 (13 Feb) but has a chance of seeing a period of suppression depending upon strength and timing of any CIR region ahead of the stronger bulk region of CH14/- later in the day. This could reduce the count rates at GEO, with low confidence for how quickly this recovers or the peak of that recovery. However, there remains a chance of High flux persisting for extended periods.

The corresponding 24 hour fluence is expected to continue rising on day 1 (13 Feb), and is likely to reach the Active threshold before any reduction occurs due to any suppression in flux from the stronger fast wind onset. This increase to Active levels is supported by REFM, although this is currently over-estimating the total fluence and also will not account for the upcoming expected fast wind enhancement. Confidence then falls for Active fluence beyond day 2 (14 Feb), however there remains a chance of ongoing Active fluence.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1\times10^{8}$** | No | 60 | 40 | 30 | 30 |
| **Very Active** | **≥ 2 MeV ≥ $1\times10^{9}$** | No | 1 | 1 | 1 | 1 |

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**Figure 5: GOES 16 >2MeV Electron Flux and associated 24hr Fluence**

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